Near-Saturation Conditions at the Tropical Tropopause: Results from Ticosonde

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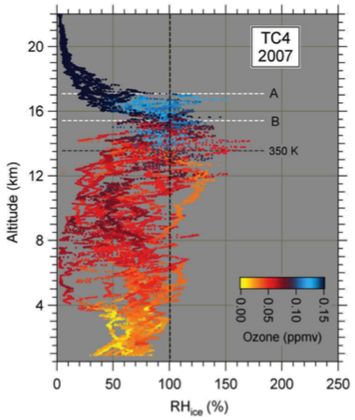
Background: The Tropical Tropopause Layer (TTL) and the Tropopause Saturation Layer (TSL)

as observed at Costa Rica during the TC4 campaign



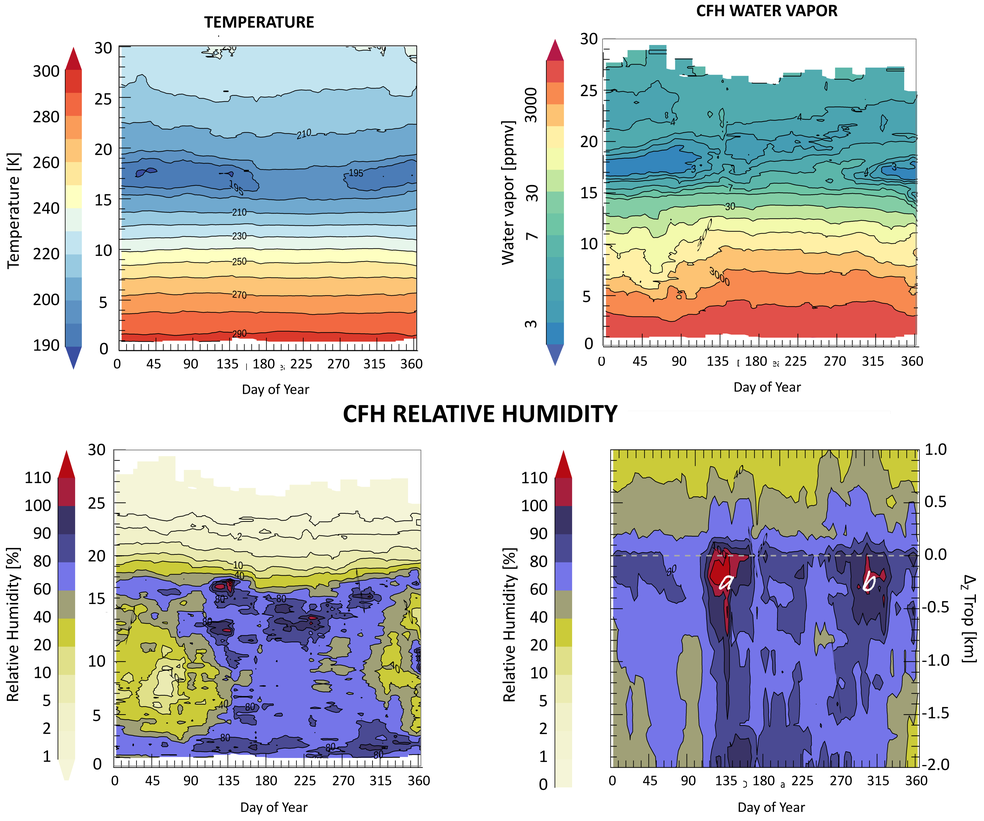
The **TTL** lies between the neutral buoyancy level (NBL) at ~350 K and the tropopause. Within the the TTL radiative heating drives ascent and air parcel supersaturation.

Ticosonde measurements since 2005 show that the incidence of supersaturation in the TTL over Costa Rica is ~60%. This is due to diabatic ascent. The frequency is highest (68%) in summer, when convection is frequent.

The TSL was defined by Selkirk et al. (2010) as the upper edge of the TTL. It is In this layer that the final saturation of air parcels rising into the stratosphere occurs and thus the water vapor minima which define the so-called "write-head" of the Atmospheric Tape Recorder.

CFH PENTAD COMPOSITES

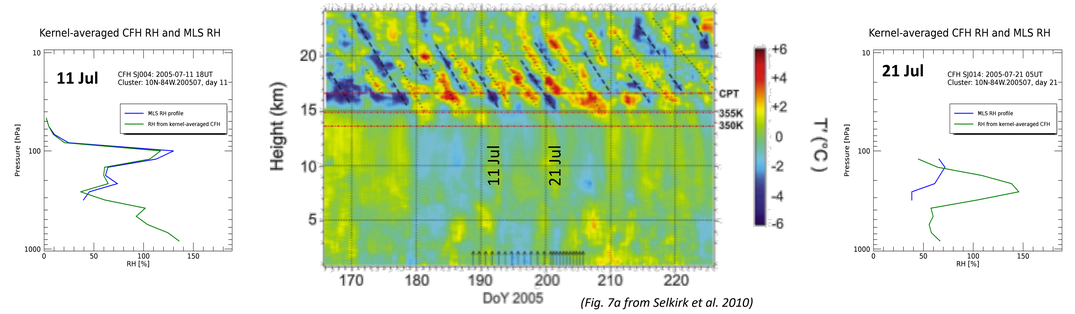
177 launches, 7/2005-6/2018



The CFH water vapor annual cycle at Costa Rica [upper right] shows the classic signature of the water vapor tape recorder. In contrast, the annual cycle in relative humidity [lower left] shows bursts of high values - and occasional supersaturation - in the UTLS, but no clear pattern other than higher values in the extensive rainy season. A much clearer pattern does emerge when RH is plotted relative to the coldpoint tropopause. Two episodes of supersaturation [*a* and *b*] within several hundred meters of the tropopause are seen to occur near days 135 and 300.

Wave-driving and episodic supersaturation in summer convective regime

11- 21 July 2005

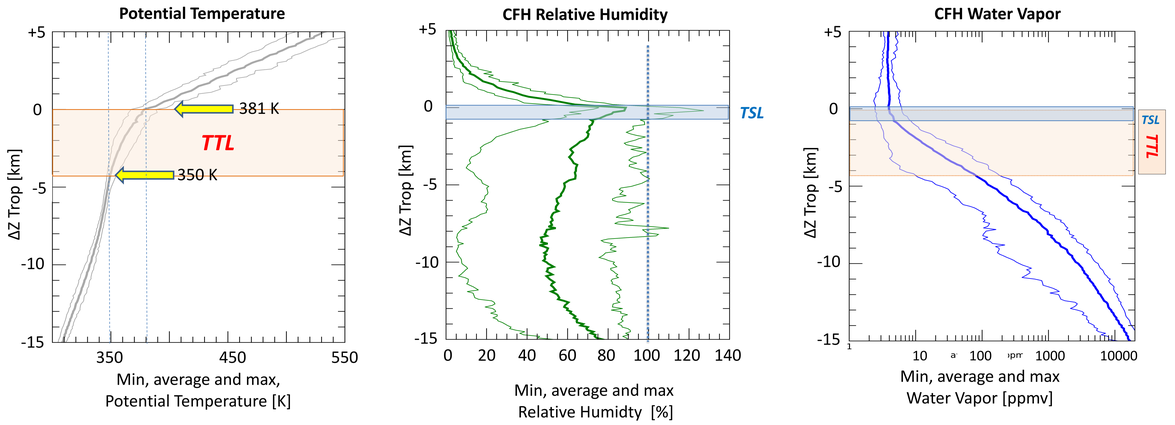


(Fig. 7a from Selkirk et al. 2010)

Supersaturated soundings on July 11 & 12 and 10 days later on July 20 & 21 were in a cold period driven by equatorial waves. Supersaturation disappears in July 16 and 17th soundings in a downwelling/warming period.

THE TTL and TSL DEFINED by CFH PROFILES wrt TROPOPAUSE

177 launches, 7/2005-6/2018



At left, the upper boundary of the TTL at ~381 K conforms to an inflection point in the theta profile wrt the coldpoint tropopause (CPT). In the center panel, we independently define the TSL as the layer in which supersaturation has occurred at least once in the data period. The TSL thus emerges as an ~1 km-thick layer with an upper edge only slightly above the upper edge of the TTL, separately defined by the CPT. Finally, in the righthand panel, we plot the TSL and the TTL together on the water vapor plot. Above the TSL, the CFH water is nearly constant.

CONCLUSION

Plotting the structure of the UTLS with respect to the tropopause shows that the episodic supersaturation events that ultimately determine the water vapor content of the stratosphere occur in the TTL generally, but only in the final km below the tropopause. This **Tropopause Saturation Layer** can be defined using frostpoint measurements of relative humidity.

The TICOSONDE Project is an ongoing joint US and Costa Rican project supported by NASA that has been making balloon sonde measurements of water vapor and ozone in Costa Rica since July 2005 and of volcanic SO_2 since February 2012. Through mid-2019, we have delivered 583 ECC ozone profiles and 216 CFH water vapor profiles to the SHADOZ and NDACC archives, respectively. Since 2009, support for Ticosonde water vapor and ozone measurements has been provided by the NASA Upper Atmosphere Composition Observations program (UACO). Additional support has been provided by the Aura Science Team, the NASA USPI and the Tropospheric Chemistry programs.